Give your ESP32s the gift of serviceability

Toit

$\overbrace{\text{Give your ESP32s}}^{\text{microcontroller}}$ the gift of $\underbrace{\text{serviceability}}_{\text{sounds great! what is it?}}$

Give your ESP32s the gift of serviceability

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BROWSERS ALSO NEED TO BE FASTER. THEY NEED TO START FASTER, LOAD PAGES FASTER --
-- AND FOR WEB APPS, JAVASCRIPT ITSELF CAN BE A LOT FASTER.
Lars Bak, Software Engineer
Kasper Lund, Software Engineer

Kasper Lund, co-founder and CEO of Toit

Our founding team have a few familiar faces ...

Toit

Kasper Lund
Co-founder & CEO

Senior Staff Engineer, Google
Co-led development of Google's V8
Led development of Dart

Erik Corry
Co-founder

Senior Engineer, Google
Built the world's fastest regex engine

Anders Johnsen
Co-founder

Software Engineer, Google
Senior Engineer II, Uber

Florian Loitsch
Co-founder

Senior Engineer, Google
PhD in Computer Science

Decades of experience implementing the world's most widely used software platforms

node JS · mongoDB

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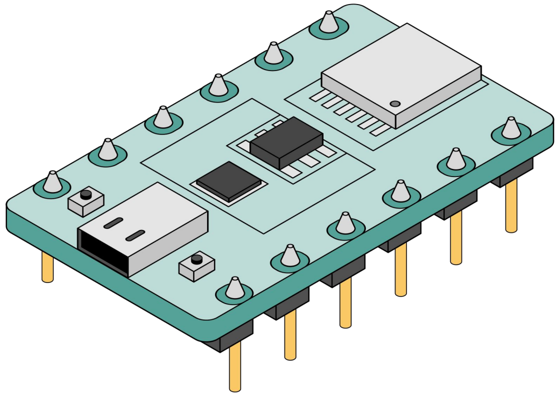
In 2018, we learned of the ESP32 ...



Powerful

Dual-core 240 MHz RISC CPU
520 KB RAM, 4MB+ Flash
Built in WiFi / Bluetooth

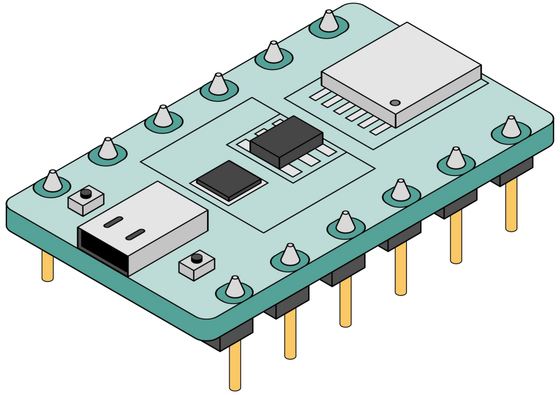
Runs on batteries

Practical drain in sleep mode is ~10 uA
Runs for years on AA batteries

Inexpensive

Development kit costs 8€ / 60 DKK
Standalone chip costs 2€ / 15 DKK

For a lot of interesting use cases, this is a ...



… compelling alternative to the Raspberry Pi

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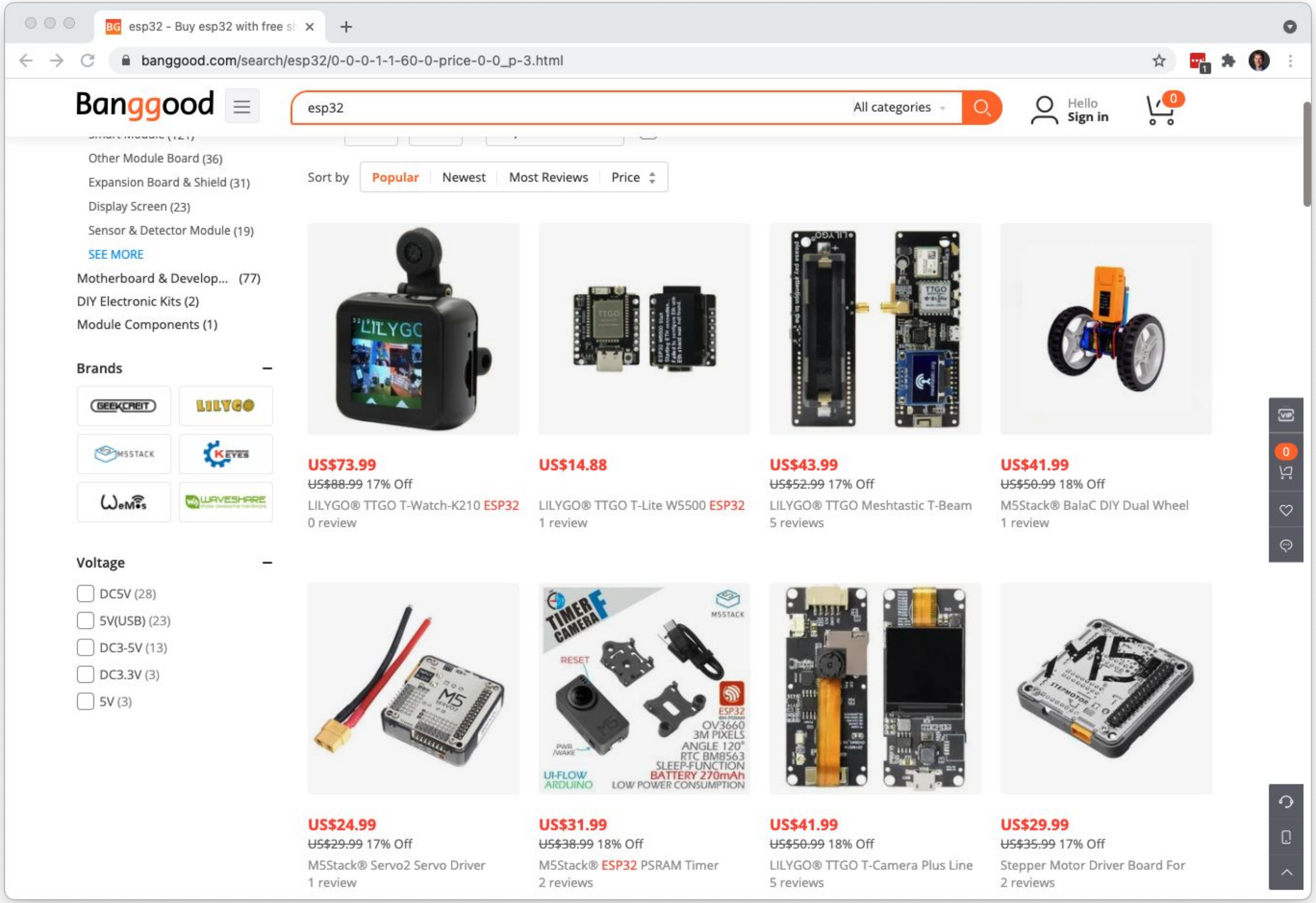

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US$73.99
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1 review

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LILYGO® TTGO T-Camera Plus Line
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Stepper Motor Driver Board For
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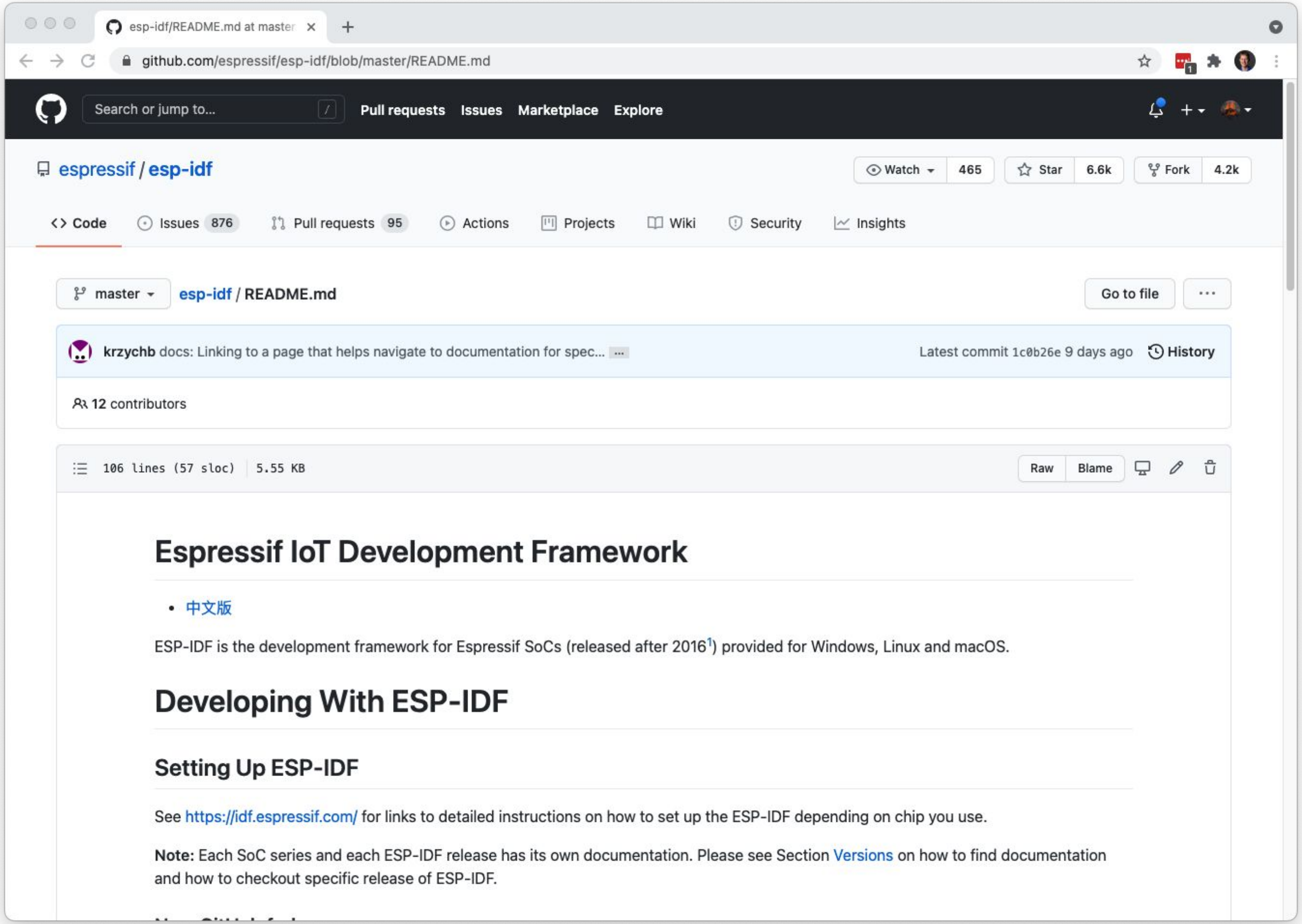


Espressif IoT Development Framework

- 中文版

ESP-IDF is the development framework for Espressif SoCs (released after 2016[1]) provided for Windows, Linux and macOS.

Developing With ESP-IDF

Setting Up ESP-IDF

See https://idf.espressif.com/ for links to detailed instructions on how to set up the ESP-IDF depending on chip you use.

Note: Each SoC series and each ESP-IDF release has its own documentation. Please see Section Versions on how to find documentation and how to checkout specific release of ESP-IDF.

Developing for microcontrollers kinda sucks ...

- Thin, if any, separation between application, drivers, and OS
- Monolithic, close-knit system software tied to specific hardware
- C and assembly are the common source languages
- Application errors often result in crashing the entire device
- Development cycles are looooong

In spite of the hardware advances in microcontrollers, the development experience just doesn’t compare favorably to server, desktop, or mobile development.

… because it is all about firmware

Fantastically firm

Get it right the first time!

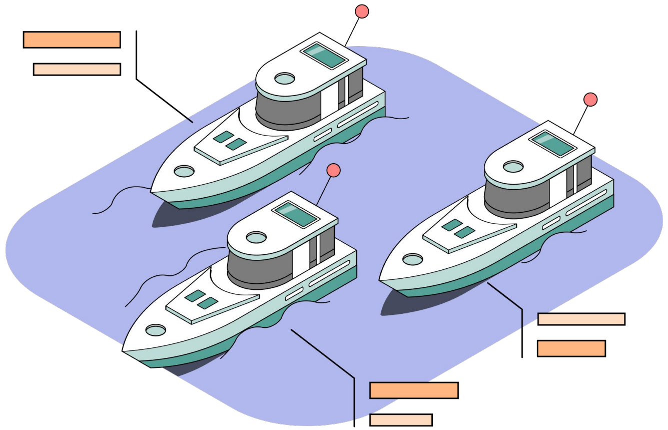
Sufficiently soft

Learn fast and feel free to change your mind

Friends don't let friends waste their time on firmware :)

It’s a UNIX system.
I know this.

Serviceability is more than observability



sɜːvɪsəˈbɪlɪtɪ

The ability to install, configure, and monitor computer products, identify exceptions or faults, debug or isolate faults to root cause analysis, and provide hardware or software maintenance in pursuit of solving a problem and restoring the product into service.

How do you get serviceability for an ESP32?

Keep on truckin'

The software must be robust and **resilient** in the presence of bugs and faults. There is no way to service a bricked device.

Tell what's going on

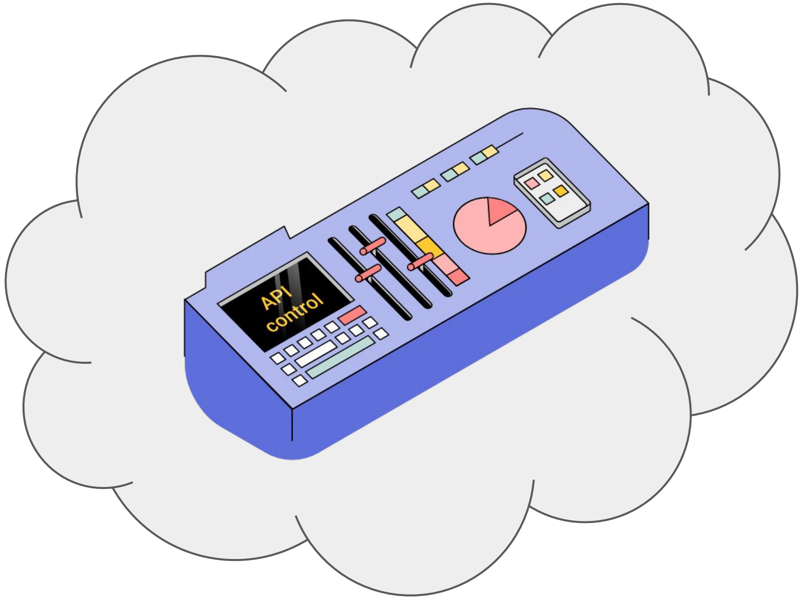
Event logging and telemetry metrics are critical tools to **understand** the behavior of the code running on the device.

Ask for direction

The system needs to prioritize taking direction and requests from an external orchestrator. This way you can **upgrade** and configure even in production.

Luckily we've got a hammer ...

… in the form of a virtual machine



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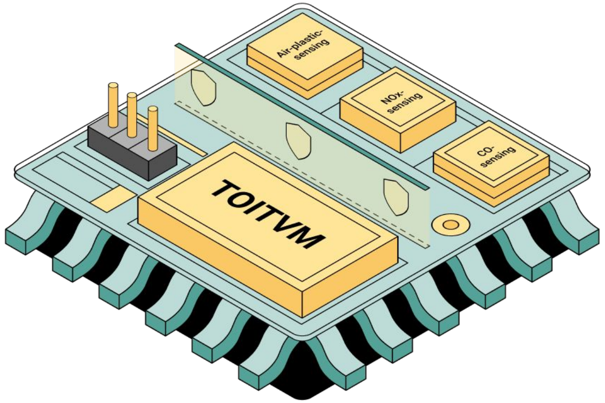

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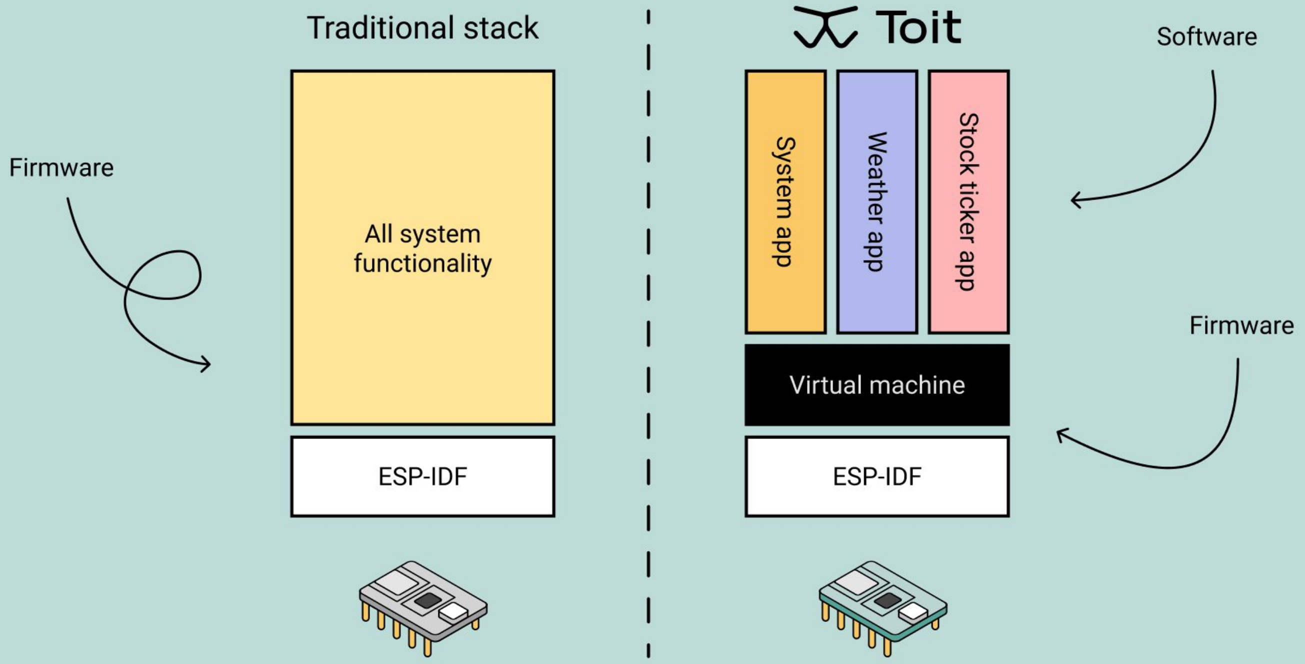
Cloud-managed containers on microcontrollers

Sandboxed environment for your ESP32 code,
fully controlled through a rich cloud API.


Traditional stack
Firmware
All system functionality
ESP-IDF
Toit
Software
System app
Weather app
Stock ticker app
Firmware
Virtual machine
ESP-IDF

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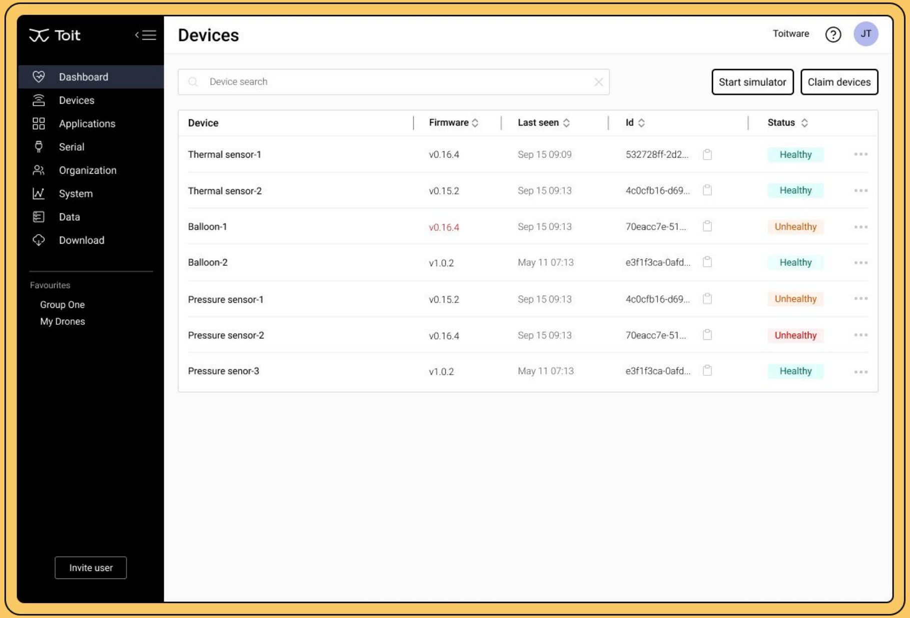
Get an overview through the **console**

Dashboard for your device fleet

Monitor and gain insights

Change and experiment



Devices

Device	Firmware	Last seen	Id	Status
Thermal sensor-1	v0.16.4	Sep 15 09:09	532728ff-2d2...	Healthy
Thermal sensor-2	v0.15.2	Sep 15 09:13	4c0cfb16-d69...	Healthy
Balloon-1	v0.16.4	Sep 15 09:13	70eacc7e-51...	Unhealthy
Balloon-2	v1.0.2	May 11 07:13	e3f1f3ca-0afd...	Healthy
Pressure sensor-1	v0.15.2	Sep 15 09:13	4c0cfb16-d69...	Unhealthy
Pressure sensor-2	v0.16.4	Sep 15 09:13	70eacc7e-51...	Unhealthy
Pressure senor-3	v1.0.2	May 11 07:13	e3f1f3ca-0afd...	Healthy

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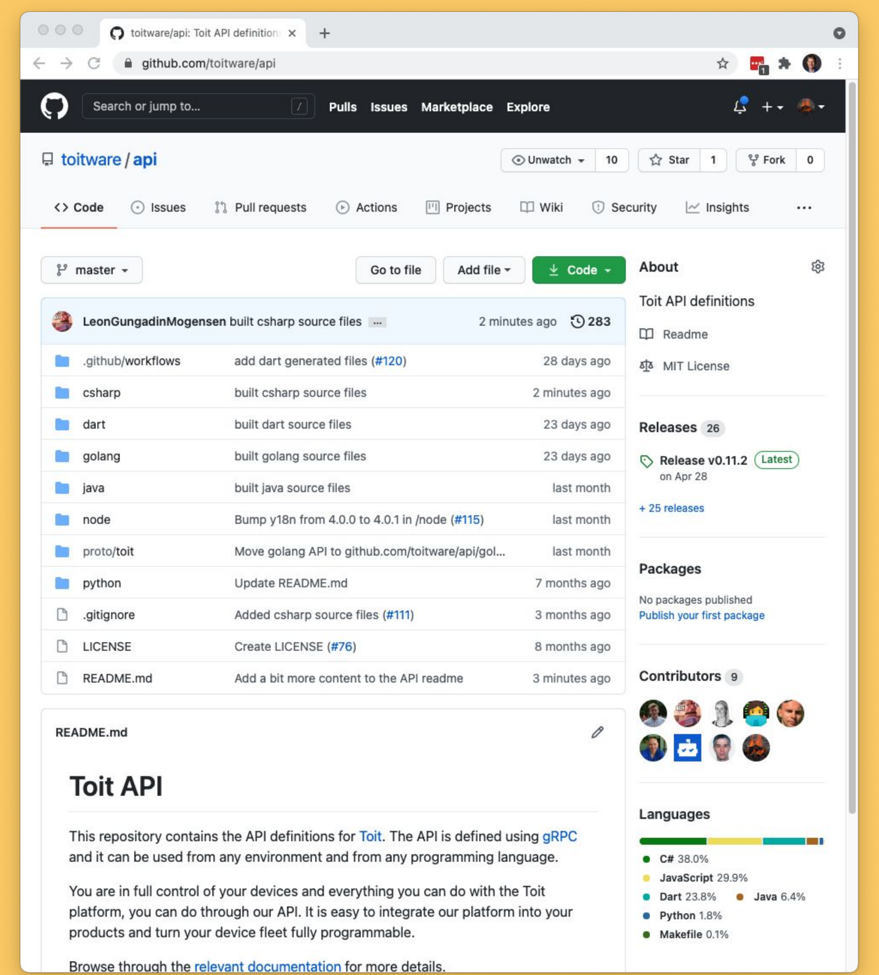


LeonGungadinMogensen built csharp source files ... 2 minutes ago 283

.github/workflows	add dart generated files (#120)	28 days ago
csharp	built csharp source files	2 minutes ago
dart	built dart source files	23 days ago
golang	built golang source files	23 days ago
java	built java source files	last month
node	Bump y18n from 4.0.0 to 4.0.1 in /node (#115)	last month
proto/toit	Move golang API to github.com/toitware/api/gol...	last month
python	Update README.md	7 months ago
.gitignore	Added csharp source files (#111)	3 months ago
LICENSE	Create LICENSE (#76)	8 months ago
README.md	Add a bit more content to the API readme	3 minutes ago

README.md

Toit API

This repository contains the API definitions for Toit. The API is defined using gRPC and it can be used from any environment and from any programming language.

You are in full control of your devices and everything you can do with the Toit platform, you can do through our API. It is easy to integrate our platform into your products and turn your device fleet fully programmable.

Browse through the relevant documentation for more details.

About

Toit API definitions

Readme

MIT License

Releases 26

Release v0.11.2 Latest
on Apr 28

+ 25 releases

Packages

No packages published
Publish your first package

Contributors 9

Languages

- C# 38.0%
- JavaScript 29.9%
- Dart 23.8%
- Java 6.4%
- Python 1.8%
- Makefile 0.1%

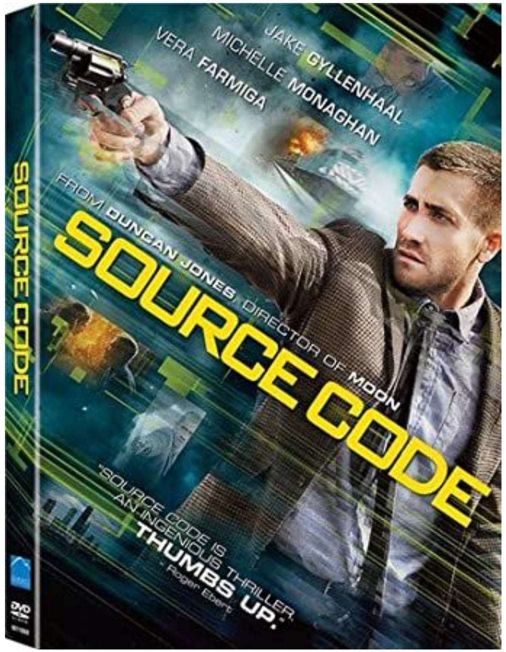
Rich **API** for servicing your devices

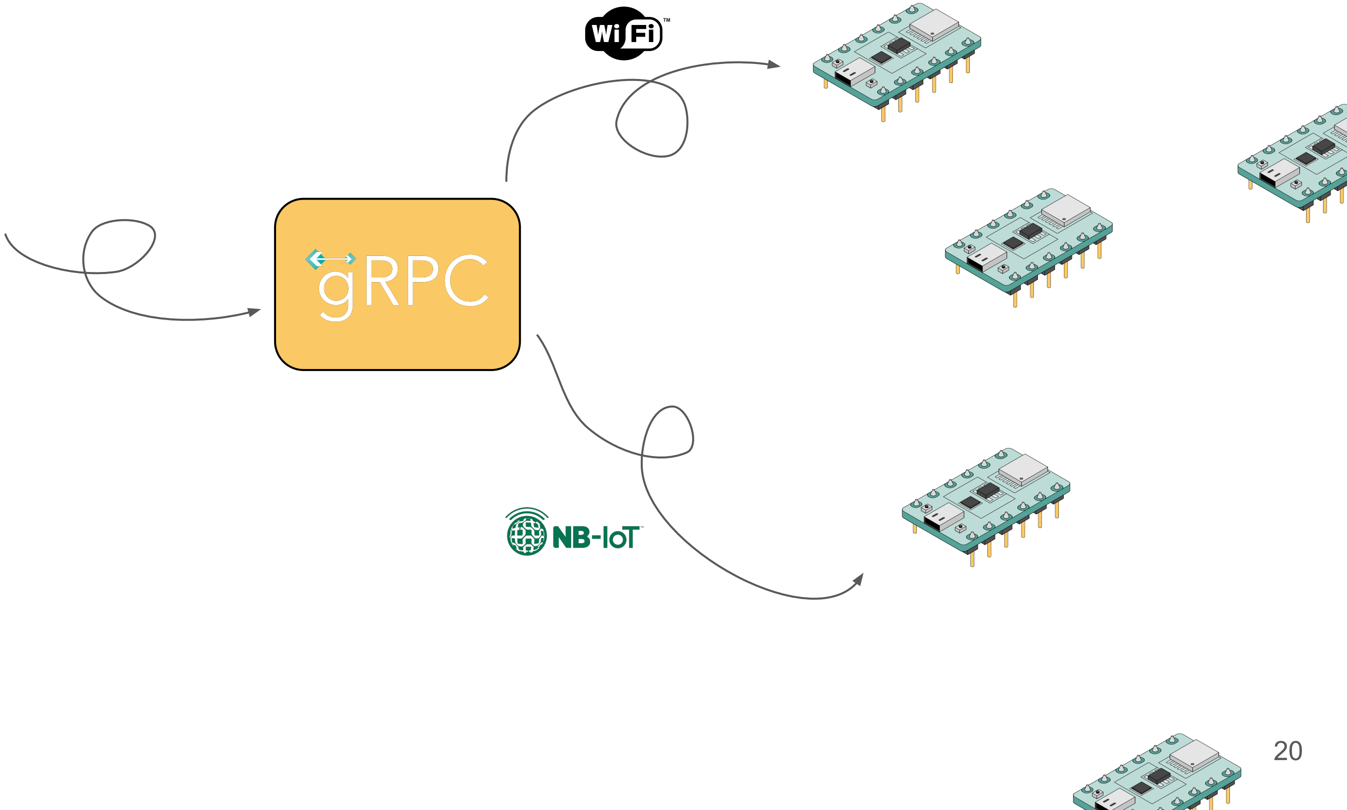
Update configurations

Install, update, and remove applications

Publish or subscribe to data

Built using gRPC


JAKE GYLLENHAAL
MICHELLE MONAGHAN
VERA FARMIGA
FROM DUNCAN JONES, DIRECTOR OF MOON
SOURCE CODE
"SOURCE CODE IS AN INGENIOUS THRILLER. THUMBS UP."
- Roger Ebert

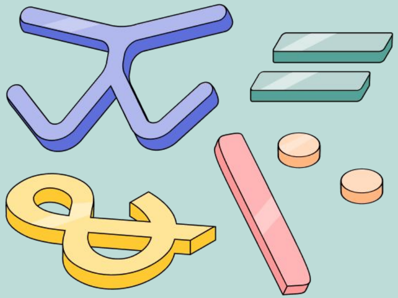

gRPC
WiFi
NB-IoT

Custom programming language

We built the **Toit language** to enable high-level programming for microcontrollers.

Hello

```
main:
  message := "Hello World"
  print message
```



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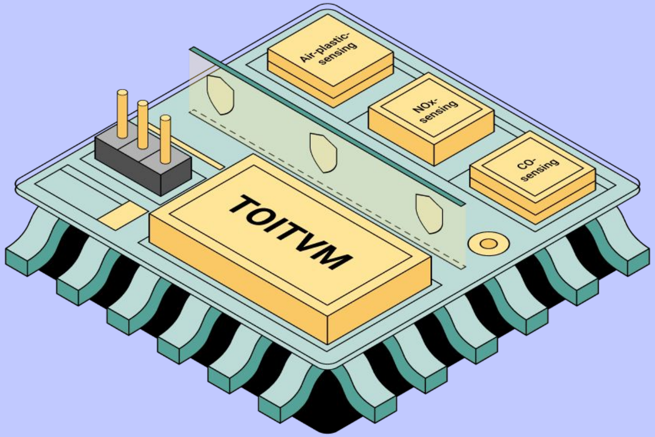
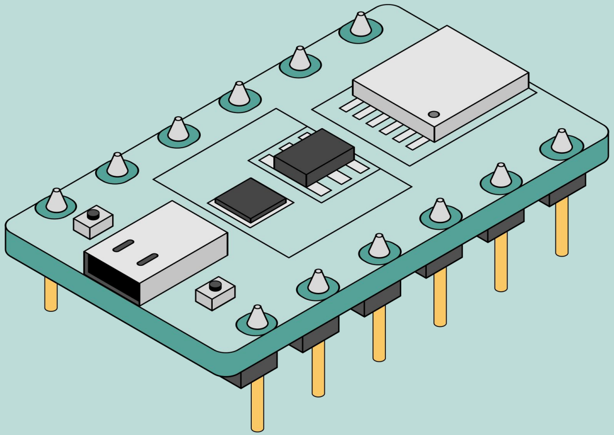
Functions

```
/// Returns the square of the given $x.
square x:
  return x * x

/// Returns the double of the given $x.
twice x/int -> int:
  return x + x
```





Classes

```
interface Vehicle:
  drive speed/int -> none

class Car implements Vehicle:
  drive speed:
    print "Driving $speed km/h"

main:
  car := Car
  car.drive 70
```

Toit

Blocks

```
when condition [body]:
  if condition:
    body.call


main:
  when true:
    print "All is well!"
  when false:
    print "Oh, noes."
```

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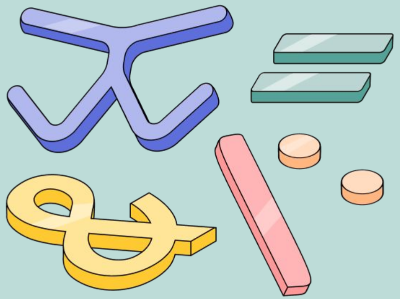
Cooperative tasks

```
main:
  unsorted := List 10: random 1000
  print unsorted
  unsorted.do: |value|
    task::
      sleep --ms=value
      print value
```

```
$ toit execute sleep-sorting.toit
[224, 812, 107, 690, 895, 71, 780, 630, 460, 624]
71
107
224
460
624
630
690
780
812
895
```



Inside the virtual machine

Sneak peek into the **engine** room.

```
months.append “April”
```

Optimized virtual dispatching without RAM based caching

Compressed using selector-based row displacement

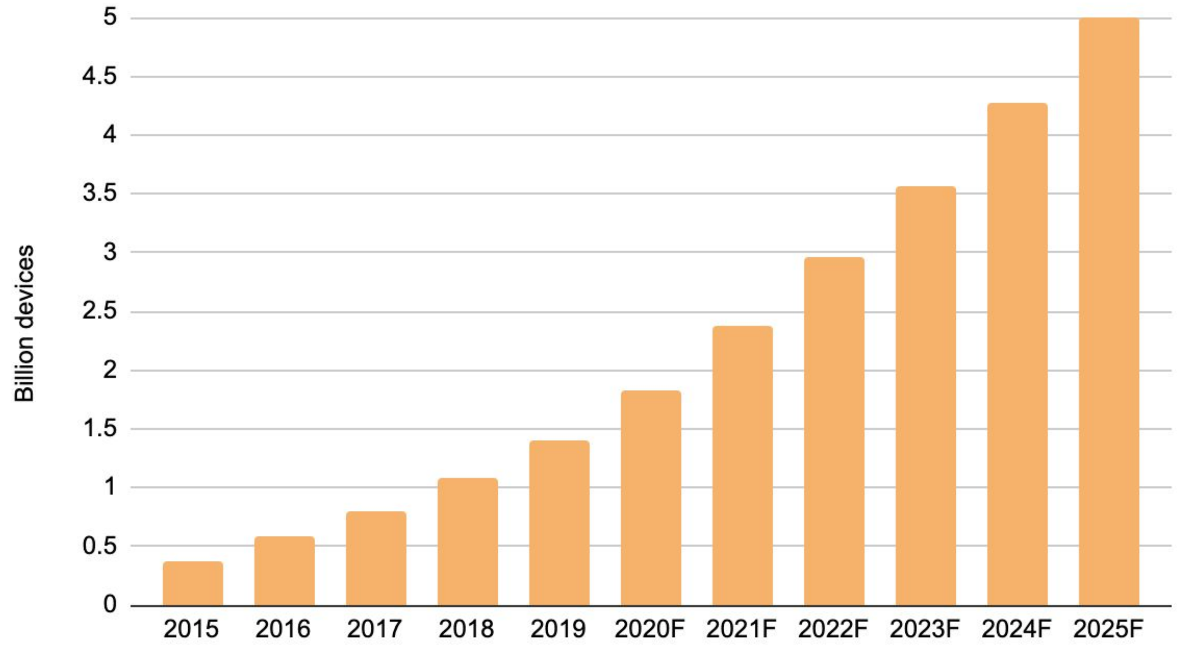
```
 0:  load local 2
 1:  load smi 2
 3:  invoke <
 4:  branch to 11 if false
 7:  load local 2
 8:  return
11:  load local 2
12:  load smi 1
13:  invoke -
14:  invoke static fib test.toit:1:1
17:  load local 3
18:  load smi 2
20:  invoke -
21:  invoke static fib test.toit:1:1
24:  invoke +
25:  return
```

Demonstration

Catch a quick glimpse of the **Toit** experience.

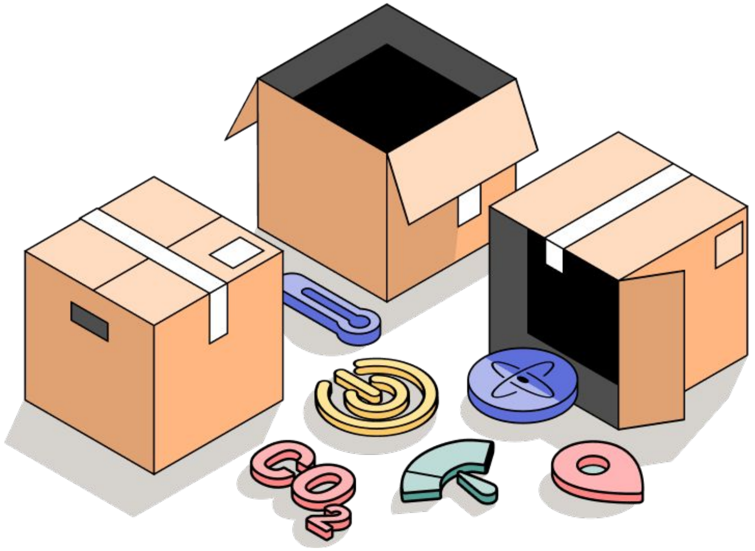
5 billion cellular connected devices will need our help!

Toit



Source: Ericsson's "Cellular networks for Massive IoT" whitepaper

Toit



To get started, we have packaged up an end-to-end platform for your ESP32s.

You can deploy your solutions on microcontrollers and run for years on batteries without giving up on serviceability.

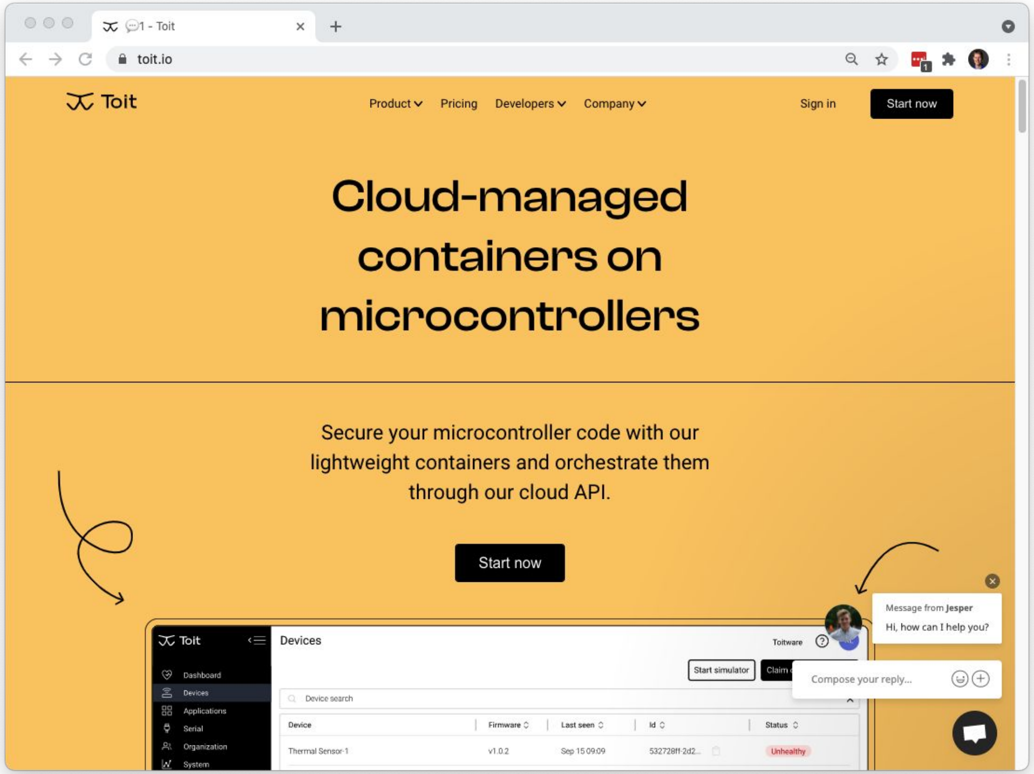
Toit 1.0 is here!

The full platform is open and easy to run on your own ESP32s.

You can sign up today for free via

https://toit.io/

and try a new development experience for microcontrollers.



Cloud-managed containers on microcontrollers

Secure your microcontroller code with our lightweight containers and orchestrate them through our cloud API.

Device	Firmware	Last seen	Id	Status
Thermal Sensor-1	v1.0.2	Sep 15 09:09	532728ff-2d2...	Unhealthy

Message from Jesper
Hi, how can I help you?

Thank you!

Questions?

Toit